

CARBON HEATING APPARATUS USING A GRAPHITE FELT AND MANUFACTURING METHOD THEREOF

BACKGROUND OF THE INVENTION

5 1. Field of the Invention

The invention relates to a carbon heating apparatus using a graphite felt and manufacturing method thereof. More specifically, the invention relates to the carbon heating apparatus using a graphite felt and manufacturing method thereof characterized in that: in a
10 carbon heater used in equipment for heating a room or applying heat, and so on by an electrical heating characteristic of a carbon fiber, wherein the electrical heating characteristic is produced by sealing the carbon heater, formed by cutting the carbon fiber into a predetermined section and length, into a quartz glass tube, a particle structure on a side face, formed more unevenly over a particle structure on a plane by cutting a plane shape of the
15 mineral carbon fiber into the predetermined section and length, becomes a stable structure by a predetermined process, i.e., a heat treating process; and an arc discharge or a terminal secession produced between the carbon heater and a feeding terminal can be prevented by using superior metals in contraction strength or compression strength, in both ends of the heat-treated carbon heater.

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Description of the Related Art

Generally, in the carbon heating apparatus using as a heat source heat produced by the arc discharge and Joule heat and producing a high temperature of heat by the arc discharge

and contact resistance between carbon particles, produced in response to an electric current flowing into the both ends of the carbon particles received in an insulator, since the carbon fiber was invented at an early age, the carbon heating apparatus has been constituted to produce heat by applying electricity to the both ends of the carbon heater, wherein the both
5 ends of the carbon heater use directly carbon yarns, a plurality number of carbon yarns spun, or a textile type of a graphite felt cut as need. Also, although the carbon heating apparatus is constituted to form a smooth cycle by injecting an inert gas, typically using a silica glass or a hard glass, the hard glass is not fit to be a heater which continuously produces a high temperature of heat. Accordingly, in portions for producing a high temperature every process
10 as in a semiconductor manufacturing apparatus has been used from an early age a constitution that the carbon heater was sealed into a quartz glass, to prevent it from oxidizing evne in the high temperature.

According to Fig. 1 illustrating a front of the general carbon heating apparatus of the prior art, the carbon heating apparatus of Fig.1 has a structure that the carbon fiber of the
15 carbon heater is sealed into a bar shape of the quartz glass tube and the ends of the quartz glass tube are melted and sealed in the state of connecting terminals of power supply lines to both ends of the sealed carbon fiber to receive the power supply from the outside. In illustration above, the graphite felt cut into a predetermined length and sectional area is used as the carbon fiber.

20 However, the upper face of the carbon fiber such as the graphite felt is smoothly formed as shown in Fig.2, while since minute carbon particles are exposed to the outside as shown in Fig.3, its side face has a shape capable of easily being seceded by effects from the outside. In case of using the carbon heating apparatus upon heating or cooking, despite precisely controlling and cutting the sectional area and length to precisely derive a required

resistance value and a result value of a consumption power, users would typically use having the graphite felt cut by a desired region as need, using tools such as a knife or scissors, etc.

At this time, in state that the minute carbon particles or the no woven pieces, having not been seceded yet from the body of the graphite felt, are exposed to the outside, if it is immediately sealed into the quartz glass tube, the exposed pieces are joined with the inside of the quartz glass tube to produce arc and also to suppress cycle when the particles evaporated into the inside wall of the quartz glass tube are heated, thereby to have bad effect on thermal efficiency and durability of a lamp, and a life of a machine.

On the other hand, the both ends of the carbon fiber processed as above use materials such as molybdenum or nickel to make terminal, and as a general method, it is processed to have a shape of a spring.

In this case, there are generated several problems due to contraction strength or compression strength. In case of connecting the both ends of the carbon fiber using the spring shape of terminal, between the terminal and the carbon fiber materials is produced discharge to cause contraction and expansion actions to each other, thereby to short there between or secede the fiber itself from the terminal, and to increase contact resistance there between to have bad affect on durability.

SUMMARY OF THE INVENTION

The invention has been proposed to solve the problems described above. It is an object of the invention to provide a smooth shape of a carbon heater and manufacturing method thereof, not having minute carbon particles or no woven pieces capable of remaining in the outside of a graphite felt cut into a predetermined length and width, upon making the

carbon heater using a carbon fiber such as the graphite felt.

It is other object of the invention to prevent a local arc from occurring to allow cycle to smoothly progress when the carbon heater is heated, thereby to enhance thermal efficiency and durability of the carbon heater, wherein the local arc can be produced by the minute
5 carbon particles or the no woven pieces remaining in the quartz glass tube into which the carbon heater is sealed,

It is another object of the invention to improve a structure of a terminal fixing both ends of the carbon heater to prevent them from being seceded from it due to contraction and expansion actions to each other, thereby to previously prevent arc from occurring.

10 The other objects of the invention will be described more fully in conjunction with constitutions and actions described below.

BRIEF DESCRIPTION OF THE DRAWINGS

15 Fig. 1 is a front view showing a conventional typical carbon heating lamp.

Fig. 2 is a plane view showing a plane state after cutting a carbon fiber used in the conventional carbon heating lamp.

Fig. 3 is a side view showing a side face state after cutting the carbon fiber used in the conventional carbon heating lamp.

20 Fig. 4 is a front view showing a carbon heating apparatus according to the invention.

Fig. 5 is a partially enlarged perspective view showing a plane state and side face state of the preferred carbon heater according to the invention.

Fig. 6a is a plane view showing the first embodiment of terminal portions according to the invention.

Fig. 6b is a side view showing the first embodiment of the terminal portions according to the invention.

Fig. 6c is a front view showing the first embodiment of the terminal portions according to the invention.

5 Fig. 7a is a partially enlarged plane view showing the first embodiment of the terminal portions according to the invention.

Fig. 7b is a partially enlarged front view showing the first embodiment of the terminal portions according to the invention.

10 Fig. 8a is a plane view showing the second embodiment of the terminal portions according to the invention.

Fig. 8b is a side view showing the second embodiment of the terminal portions according to the invention.

Fig. 8c is a front view showing the second embodiment of terminal portions according to the invention.

15 Fig. 9a is a partially enlarged plane view showing the second embodiment of the terminal portions according to the invention.

Fig. 9b is a partially enlarged side view showing the second embodiment of the terminal portions according to the invention.

20 Fig. 10a is a plane view showing the third embodiment of the terminal portions according to the invention.

Fig. 10b is a side view showing the third embodiment of the terminal portions according to the invention.

Fig. 10c is a front view showing the third embodiment of the terminal portions according to the invention.

Fig. 11a is a partially enlarged plane view showing the third embodiment of the terminal portions according to the invention.

Fig. 11b is a partially enlarged side view showing the third embodiment of the terminal portions according to the invention.

5 Fig. 12 is a flow chart showing a preferred manufacturing method of the carbon heating apparatus according to the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

10 The carbon heating apparatus of the invention to solve the problems as described above characterizing by comprising: a carbon heater processed by cutting a predetermined carbon fiber in a constant form to have a predetermined length and width and performing a heat treatment against the side face cut in hydrogen gas atmosphere of a predetermined temperature; terminal portions connected with the outside power supply lines of a
15 predetermined material to provide an electrical connecting path to both ends of the carbon heater; and a quartz glass tube melting-joined in state that the carbon heater is sealed and the terminal portions are located at the both ends of the carbon heater.

Preferably, in the carbon heater sealed into the quartz glass tube is inserted a ribbon of molybdenum having a predetermined thickness and width to prevent oxidation of carbon
20 by air penetrated into the quartz glass tube upon producing a leak therein, thereby to protect functions of the heater, wherein the ribbon of molybdenum has preferably thickness 28 to 30 μ m and width 3 to 4mm.

Also, the carbon heater can be formed preferably in a bar shape having a tetragonal section, wherein one end of the terminal portions is formed in a circle of a metal thin film

surrounding the carbon heater, while other end of the terminal portions is extended from the circle of the metal thin film and welded with the outside power supply lines.

Further, since the carbon heater uses mineral carbon materials such as coke or coal, and so on to be capable of outputting about 800 watt of a high output, it can be constituted to
5 bear up against a high temperature of heat.

Also, the carbon heating apparatus manufacturing method according to the invention characterizing by including the steps of: forming a carbon heater by cutting a predetermined carbon fiber in a constant form to have a predetermined length and width; heat-treating the cut carbon heater in hydrogen gas atmosphere of a predetermined temperature under a high
10 vacuum to make its surface uniform; after putting the carbon heater heat-treated into a quartz glass tube and injecting the hydrogen gas, baking it at a predetermined temperature to remove impurities; primary aging the carbon heater baked by applying a primary aging voltage to it; secondary aging the carbon heater by applying a secondary aging voltage to it; and after confirming the vacuum state, sealing the quartz glass tube.

15 Preferably, the process for cutting the carbon fiber may includes a press cutting or a laser cutting methods, and so on to cleanly form its side face cut as much as possible.

Also, the heat-treating step is made for about 2 to 3 minutes in the hydrogen gas of 900 to 1000 °C under a high vacuum of at least 10^{-5} Torr, the baking step is made at the temperature of 1600 to 1700 °C to remove impurities, and the primary aging voltage of 60 to
20 70V and the secondary voltage of a rated voltage 100V may be applied. The preferred embodiments of the invention will be described below more fully with reference to the accompanying drawings.

In the following description of the preferred embodiments of the invention, detailed descriptions of well-known functions or constitutions are omitted so as not to obscure the

subject matters of the present invention with unnecessary detail. The terms described below are established taking into account the functions of the invention. However, since the terms may be changed in accordance with manufacturer's intention or practice, the meanings of the terms should be defined based on the whole contents of the specification.

Fig. 4 is a front view showing a carbon heating apparatus according to the invention, and Fig. 5 is a partially enlarged photograph showing a side face state of a preferred carbon heater according to the invention.

Referring to Fig. 4, a quartz glass tube 10 uses any one of a quartz glass made by melting crystal, a quartz glass made from a high purity of SiCl_4 , SiH_4 , and so on as starting ingredient, a quartz glass made by melting silica, and a quartz glass made from silica glass as ingredient.

In case of using the quartz glass made from the silica glass as ingredient, it is typical to make a film layer of the quartz glass, by a method including the steps of: molding the silica glass at about 550 to 620 °C; dividing into B_2O_3 - Na_2O phase and SiO_2 phase; making an acid treatment with hydrochloric acid etc.; and making a heating process at about 1000 to 1200 °C, and other methods.

Also, the quartz glass tube 10 of the invention uses the purity 99.5% of SiO_2 and a working point of 1700 °C, as represented in Table 1.

Table 1

No	Ingredient	Coefficient of thermal expansion	Specific gravity	Stress point °C	Annealing point °C	Softening point °C	Working Point °C
1	99.5% of SiO_2	5.5	2.2	956	1084	1580	1700
2	Corning 1742	45		745	820	1015	1300
3	GE 180	44	2.64	674	726	928	1200

Also, the quartz glass tube 10 typically has thickness of about 0.04 to 3mm on average to obtain an enough mechanical strength.

The most characteristic portion of the invention is the carbon heater 20 sealed into the quartz glass tube 10, wherein the carbon heater 20 is constituted cutting the graphite felt known as a carbon fiber into a desired length and a predetermined width fitted with resistance value.

The graphite felt used in the invention is manufactured using mineral carbon materials such as coke or coal, etc. Since it is possible for the use of the mineral carbon materials to output a high watt of a high output beyond a heating range capable of being emitted from vegetable carbon materials, it is advantages that the graphite felt can bear up against a high temperature of heat and can be designed to be coincided with any rated voltages in the range of 100 V to 220V.

And, the method for cutting the graphite felt includes a method using a press cutting, a dedicated jig, or a wire cutting method that does not produce carbon particles or no woven pieces on the side face cut as much as possible.

The amount that the carbon particles or the no woven pieces are exposed to the outside is sharply reduced in the side face of the carbon heater 20 cut by the press cutting, the dedicated jig, or the wire cutting, in comparison with the method using scissors or a knife of the prior art. However, comparing that the upper face of the carbon heater 20 is smoothly formed, the side face of which the section structure is relatively rough is formed. As the result, the side face cut is heat-treated for about 2 to 3minutes in hydrogen atmosphere of 900 to 1000℃ to change its physical properties, thereby to form the side face similar to the smooth surface of the upper face.

The carbon heater 20 is heat-treated before it is sealed into the quartz glass tube 10,

thereby making its side surface smooth simultaneously with removing impurities remaining in its side face. As the result, nothing remains impurities, upon inserting the carbon heater 20 heat-treated into the quartz glass tube 10.

A terminal portion 30 is constituted to connect the carbon heater 20 to the outside power supply line 40 for providing an electrical path and a mechanical connection. The terminal portion 30 is preferably consisted of metal materials such as molybdenum or nickel, wherein it may take various embodiments according to the invention as shown in Fig. 6A to Fig. 10. In Fig. 4, the terminal portion 30 takes the form of the first embodiment illustrated more fully in Fig. 6A to Fig. 7B.

According to Fig. 6A to Fig. 6C, one end is constituted into a terminal portion 31 for a power supply, welded to the outside power supply line 40, while other end is constituted into a terminal portion 32 for the carbon heater, wherein the end of the carbon heater 20 may be arrived safely and fixed at and to the inside of the terminal portion 32.

The terminal portion 32 for the carbon heater is further mounted with supporting protrusions 33 that can firmly clasp the carbon heater 20 arrived safely at the inside to prevent it from seceding easily.

Fig. 7A and Fig. 7B are partially enlarged views showing the terminal portion 30 according to the first embodiment. Between terminal portion 30 constituted as above and the carbon heater 20 is not caused discharge.

Accordingly, events, such as a short by contraction and expansion actions to each other or the secession of the fiber itself from the terminal, are not caused, and the contact surface is much wider than that of a conventional spring form to reduce contact resistance and to enhance durability.

Fig. 8 to Fig. 11B show the second and the third embodiments of the terminal

according to the invention, and Fig. 8A to Fig. 9B show a connection member 50 between the terminal 30 and the outside power supply line 40. Fig. 10A to Fig. 11B show the constitution that the terminal portion 32 for the carbon heater is formed with bent parts so that the spring can be fixed into its both sides to prevent it from coming off.

5 Also, although not shown, making the conventional spring terminal of about 5mm into a spring terminal of 8 to 10mm can significantly enhance durability.

On the one hand, Fig. 12 is a flow chart showing a preferred manufacturing method of the carbon heating apparatus according to the invention.

The method according to the Fig. 12 includes the steps of: forming the carbon heater
10 by cutting the carbon fiber such as the graphite felt into a constant form to have a predetermined length and width (step S1), wherein the length and width of the carbon heater is defined considering a desired resistance value and density and the cutting method uses the press cutting or the laser cutting, etc.;

heat-treating the carbon heater cut in the step S1 for about 2 to 3 minutes in the
15 hydrogen gas atmosphere of 900 to 1000 °C under a high vacuum at least 10^{-5} Torr to make its surface uniform (step S2);

after putting the heat-treated carbon heater into a quartz glass and injecting the hydrogen gas, baking it at 1600 to 1700 °C to remove impurities(step S3);

primary aging the carbon heater baked in the step S3 by applying a primary aging
20 voltage to it (step S4);

secondary aging the carbon heater that has undergone the primary aging by applying a secondary aging voltage to it (step S5); and

sealing the inside of the quartz glass tube into which the carbon heater is sealed, after confirming a vacuum state, once the secondary aging is completed in the step S5 (step S6),

wherein upon melting and molding the quartz glass tube, it would typically use LPG O₂ burner, but the invention uses a hydrogen burner of a high temperature of 1500 to 1700 °C as much as possible to mold it in a short time with minimizing the effect on carbon materials.

Assuming that the carbon heating apparatus is manufactured according to the method, the side face of the carbon heater cut is heat-treated in step S2 to make its surface properties uniform and at the same time to remove impurities, the carbon heater becomes stable through the aging processes of steps S4 and S5, and the quartz glass tube is melting-sealed in the shortest time using the hydrogen burner of a high temperature in step S6 to prevent stress from being exerted on the carbon materials.

Also, the other heat-treating method according to the invention includes the steps of: heat-treating the cut carbon heater for about 2 hours under a high temperature of 300 °C in process corresponding to the step S2, and then slowly cooling it for 1 hour to make the section structure of the side face thereof stable; and putting it into the quartz glass tube and performing the baking and aging processes through the step S3, S4 and S5.

After the vacuum process for the quartz glass tube is completed, dibromoethane of the mixed gas of methylene 0.25% and bromide 70% is injected and sealed into it and then its both inlets are sealed. After this, the carbon heater in which the aging has been undergone is heat-treated for about 2 hours under a high temperature of 300 °C

Although the preferred embodiments of the present invention have been disclosed as describe above, those skilled in the art will appreciate that various modifications and changes are possible, without departing from the scope and spirit of the invention. The technical protective range will be defined by accompanying claims

The invention can provide a smooth shape of a carbon heater not having minute carbon particles or no woven pieces capable of remaining in the outside of a graphite felt cut

into a predetermined length and width, upon making the carbon heater using the carbon fiber such as the graphite felt; and prevent a local arc from occurring to allow cycle to smoothly progress when the carbon heater is heated, thereby to enhance thermal efficiency and durability of the carbon heater, wherein the local arc can be produced by the minute carbon particles or the no woven pieces remaining in the quartz glass tube into which the carbon heater is sealed,

Also, the invention improves a structure of a terminal fixing both ends of the carbon heater of which the side face is improved through a heat treatment according to the invention to prevent them from being seceded from it due to contraction and expansion actions to each other, thereby to previously prevent arc from occurring.

Further, the invention can manufacture a carbon lamp which can output consumption power of at least 800 W and which can be used even in voltage of at least 220V, wherein the lamp is widely applied to various industrial products such as a roast fish utensil, a kitchen utensil, an electric stove, a duplicator, an electric heat remedy utensil.